Network Position and Cognition

by

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A central issue in administrative theory is the relationship between organization and cognition (Simon, 1976, p. 241). Organizations are typically larger and more differentiated than small groups, and organizational members in functionally distinct groups may interpret problems differently (Dearborn and Simon, 1958; March and Simon, 1958, Chapter 6). But as the diversity of outputs produced by the organization grows, individuals are typically grouped according to the products worked on, controlling for economies of scale in functional specialties (Chandler, 1962; Galbraith, 1974). Because of differences in markets served and, possibly, in production technologies product groups may vary in their perceptions of how to solve problems. These perceptions based on product groupings may interfere with the cognitive differentiation based on function. Furthermore, when the organization faces relatively high input and output market uncertainty, product or functional groups may be linked by an organization-wide network of lateral relations (Lawrence and Lorsch, 1967) which may confound the distinctiveness of the group perspectives. The present research isolates such a network effect and demonstrates its dominance over other sources of cognitive bias.

The study was carried out in a contract computer software firm chosen for its size, technology and type of business, each of which may contribute to the influence of the network on cognition. The organization studied here is large enough to be differentiated into functional roles; but since software production entails diseconomies rather than economies of scale (Brooks, 1975), extensive related product diversification (Rumelt, 1972) has led to an organizational structure of project groups. The firm is small enough, however, to have a relatively dense network of strong ties throughout the organization (Mayhew and Levinger, 1976), and the "intensiveness" (Thompson,

1976, Chapter 2) and labor intensity of the firm's technology increase the range of opportunities organizational members have to establish task relationships. Consequently, the combination of the software firm's size and technology makes a strong inter-project network probable and therefore enables an examination of the network's influence on cognition.

Furthermore, because the firm is in the software business, it is presented with ill-structured problem-solving situations which are likely to be influenced by the network. In contrast to decision-making in well-structured situations which can be carried out by a single individual, solving ill-structured problems has been found to be a multi-person phenomenon (Connolly, 1976; Van de Ven, Delbecq and Koenig, 1976; Ungson et al., 1981). Specifically, the present study focuses on the perception of how product success is achieved. Identifying how to achieve product goals is a typical ill-structured problem which software firm members face, since software product markets and production technology are changing rapidly.[1]

Thus the software firm's size and technology and the uncertainty associated with the firms markets and product development procedures increase the likelihood of a relationship between a highly important type of cognition and the network of task-oriented ties. The specific nature of this relationship is now examined.

COGNITION

In the present study two dimensions are specified as central to the way the accomplishment of software product goals is perceived in the firm. The

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[1]The market for software products is both highly segmented and growing. Furthermore, software is a complex product in its design and interface with users, and the state of the art in software development is changing as attempts are made to increase both its flexibility and efficiency (Spier, 1975; Lecht, 1977; Van Tassel, 1978). As a result no identifiable consensus exists in the software industry on how to achieve product success through either marketing or product development.

term dimension is composed of two states, short term and long term product success. Responsibility for perceiving differences between short and long term goals has typically been assigned to the top management team of an organization (Chandler, 1962; Williamson, 1981). However, because of the rapid rate of technological and market change facing a software firm, members other than top management may be exposed to information relevant for estimating the duration of product success and make judgments based on this knowledge. Such judgments may be generally encouraged by top management to reduce the upward flow of exceptions generated by changing market conditions (Galbraith, 1974). Thus, the _term_ dimension may pervade the cognitive frameworks used by firm members to make judgments about how to achieve product goals relevant to different stages in the life of the product.

The second cognitive dimension pertains to differences between the way users might define product success and the way success is approached by product developers. The purposes to which a user puts the product may be quite different from the motivations of those who developed it; and in general, software users come in contact with only selected and simplified aspects of the product which is itself technically complex. Consequently, user criteria for product performance are likely to be quite different from those of software designers and programmers. Firm members may perceive in varying degrees that product user and developer goals are accomplished with different means. The second dimension, called _boundary_, represents the extent to which members make this distinction.

Firm members have a practical interest in the _term_ and _boundary_ aspects of product goals but may perceive these dimensions with varying strength. The meaning of individual differences in the perception of these dimensions can be clarified by referring to resource allocation decisions for a software product. Suppose members must make judgments about how resources are to be distributed across a set of factors which are seen as important contributors

to product success. One member may perceive that a product characteristic, such as the modularity of product design, contributes equally to short and long term goals; for this member shifting resources from the modularization of design to another characteristic would not imply a trade-off between the goals. If this member makes no distinction between the way short and long term goals are accomplished, then s/he does not perceive the term dimension as a relevant parameter of achieving product success. Another member, however, who judges that a characteristic such as modularity contributes to short and long term goals in different degrees might see substantial trade-offs in redistributing resources. For this individual the term dimension is salient. The strength with which individuals perceive the term and boundary dimensions may thus be an important input to product-related problem solving in a software firm and is what this study attempts to explain.

DETERMINANTS OF INDIVIDUAL DIFFERENCES IN COGNITION

The major proposition of the present research is that the position a firm member occupies in the organizational network of task relationships determines the strength with which s/he perceives the term and boundary dimensions in making judgments about how product goals are accomplished. Furthermore, the network is proposed as the primary influence on cognitive differences among firm members. The network effect should be independent of other sources of cognitive bias such as functional and hierarchical role (Dearborn and Simon, 1958; Herman, Dunham and Hulin, 1975; Berger and Cummings, 1979; Sonnenfeld, 1981); boundary spanning roles (Miles, 1977; Tushman and Scanlan, 1981); the life cycle of the type of product worked on (Polli and Cook, 1969); length of experience in the industry; and the stage of socialization in the firm and job Schein, 1978).

Defining Network Position. In the present study the types of relationships members have with each other are assumed to characterize inputs to

cognition (Simon, 1975), and inferences about the achievement of product goals should depend on input from task-oriented interactions.[2] Five types of functional relation compose the network studied here: reporting, dependence for information, feedback on performance, problem referral and dependence for extra resources. Inherent in these types of interaction is the transmission of product- related goals and information which provide a focus and framework for judgments about how product success is achieved.

Of the five types of relation, reporting alone strictly reflects the formal authority system. The conveyance of product-related subgoals is a central purpose of reporting relationships, and subgoals are usually seen as imposed by superiors on subordinates (Ouchi 1978). However, the transmission of product-related information may be bilateral (Evans, 1975).

The other types of tie may coincide with the formal system or breach it. For example, referral of product problems between firm members is akin to adjacency in the workflow (Chapple and Sayles, 1961; Comstock and Scott, 1977); but unlike workflow ties problem referral may be nonroutine and, in the present research is a relationship between individuals rather than activities. The

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[2]Task-oriented relationships may involve product or process issues. The focus here on product as opposed to process goals is compatible for a number of reasons with the interests of computer software firms. First, the market for software products is emerging (Porter, 1980) and characterized by high technological and market uncertainty. Firms in such industries emphasize product over process decisions since the implications of product decisions are easier to identify (Hofer and Schendel, 1977, p. 108). Second, the concern with product over process in software firms is reinforced by the technology of software production. Once a program has been written and made into a commercial product, the cost of manufacturing copies is minimal; production (as opposed to development) costs are estimated at .1 to 5% of total cost (Goetz, 1978). Therefore there is little incentive to reduce the variable cost portion of total cost through process innovation. Third, the major part of total software cost is labor, and the labor intensity of software production further reinforces product over process concerns for the two reasons: 1) software firms experience decreasing returns to scale for labor input (Brooks, 1973); and 2) programming efficiency may ultimately depend on the quality of the software used as programming tools (Lecht, 1977).

problems individuals come in contact with should provide them with information about the product and also direct their attention to deficiences in the process of goal achievement.

The network of information dependence by definition maps the flow of information in a firm. In addition to technical information flows (O'Reilly and Roberts, 1977; Fombrun, 1980; Tushman and Scanlan, 1981) the present study is concerned with dependence for marketing and administrative information, which involve product-related issues. The distribution of information in an organization may have a directive influence on inferences of how product goals are reached (March and Simon 1958, Chapter 6).

Feedback on work performance enhances the flow of the different kinds of information, since an important effect of task-oriented feedback is information sharing with respect to a particular activity (Kim and Hamner, 1976). Individuals who share the same respondents in feedback relationships are thus exposed to the same sources of task information and may be directed towards similar goals.

Finally, dependence on others for extra resources may entail the transmission of product-related goals and information. Since this type of relationship may involve justifications for requesting resources or advice on resource use. Furthermore, discretionary resource transactions should occur more frequently between individuals whose product-relevant goals are not in conflict than between those whose goals differ.

Interpersonal ties on these five types of relations compose a task-oriented network in the firm, and in the present study an actor's position in this network is defined by the concepts of structural equivalence. Individuals in a network have been defined as structurally equivalent when they interact directly with approximately the same set of network members (Breiger, Boorman and Arabie, 1975; Burt, 1978), when they share approximately the same point of direct and indirect connection to all network members (Sailer, 1977), or when

the combination of their relationships with other actors improves an index of pattern in network (Carrington and Heil, 1981). In these definitions of structural equivalence, actors are grouped by their relationships with all network members rather than by their participation in functional or project teams or in local cliques (see Burt, 1980). Actors in a position or block are similarly related to individuals in the other blocks (see Lorrain and White, 1971) and thus convey and receive similar product-related goals and information to and from other firm members. By virtue of their common exposure to the organization, structurally equivalent individuals should share the same perceptions of how product goals are accomplished. Although some subgroups may have similar cognitive orientations towards product success because their positions are similar in the network structure, there should be significant dissimilarities in cognition among the groups as a whole. These dissimilarities, furthermore, should be independent of other sources of cognitive orientation towards product success described below.

Other Sources of Cognitive Bias.

The first alternative source of bias in cognition of product outcomes is the nominal role[3] of an organizational member. Nominal roles are viewed first in terms of their position in the stream of valued added to product and second as the content of communication with users. Two types of roles, technical and management, may affect perception in both ways. A third type of role, marketing, inherently involves contact with users; and consequently its effect is evaluated only as a type of communication content.

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[3]The term "role" is used here as a nominal attribute and is not meant to be confused with its definition in the blockmodelling literature (White, Boorman and Breiger, 1976, p. 770; Boorman and White, 1976, pp. 1388 ff) where it is operationalized in terms of the network structure in a population of actors. The present research may be seen as a critical test of the effect on cognition of nominal roles vs. roles based on relations with others (cf, Komarovsky, 1973).

The predicted effect of a nominal role on perceptions of the term and boundary dimensions is based on the contribution these perceptions make to performance in the role (Dearborn and Simon, 1958). Since responding to user perceptions of a product are important to a manager's performance, managers should tend to differentiate between the ways user and developer-based types of success are accomplished. Technical personnel should not make such a distinction since user perceptions are less important to the fulfillment of their role than making the product efficient and functional and perhaps, creating new product versions. To accomplish the goals associated with their role, marketers, like managers, depend on user perceptions and therefore should recognize that user defined product goals may be accomplished in a different way from goals defined by product developers.

Management, technical and marketing roles are specified as individual rather than group attributes. Thus, project teams need not be composed of functional groups but only of individuals enacting various functions. In this way the diseconomies of scale in software production are respected. Furthermore, because individuals in a project team may be involved in more than one function , the influence on cognition of each role is weighted by the degree to which a firm member is involved in it.

Just as firm members might perform more than one function, so they might belong to more than one project team. (The firm kept no organization chart below the level of vice president.) The absence of a discrete team structure made isolating a team effect on cognition an intractable problem because of the confusion of this effect with the task network. It was possible, however, to categorize the products teams were responsible for. The three product types identified were applications, systems and telecommunications software. These types perform different data-processing functions and therefore may differ in the shape and length of their typical product life cycle. However, a member who has had extensive experience with any of the three types may have a

greater appreciation of the term dimension because of his or her exposure to a complete life cycle. Thus, the more extensive a firm member's exposure to a product type over time, the more should s/he see how differently short and long term goals are accomplished.

Similarly, veterans, more so than newcomers to the software industry, will typically have seen a number of products reach their greatest share of the market and either decline or be transformed into more current versions. Thus the longer a firm member's tenure in the industry, the more strongly should s/he perceive the term dimension of product success.

Finally, in the present research perceptions of the term dimension can be related to a penchant for innovative ideas. According to Schein (1978) organizational members are more open to innovation and change at the midpoint of their passage between the inter-and intra-institutional boundaries they cross to advance their careers. Because the advent of a new job often cannot be predicted, however, the effect of anticipatory socialization cannot be assessed. The influences of job and firm tenure on perceptions of the term dimension are therefore assumed to be positive and linear.

RESEARCH DESIGN

Cognition

Measuring cognition involved the construction of an instrument which could capture differences among firm members in the strength with which they perceived the term and boundary dimensions. To simplify the task, it was assumed that two states composed each dimension. Consistent with the theory presented, these states are short and long term for the term dimension,[4] and user and developer perspectives on product success for the boundary dimension. A prototypical product goal was then defined for each combination of states. For convenience, these goals are labelled performance, coherence, generativity and endurance (see Figure 1) and are now described.

Performance

Performance is a type of product success which occurs in the short term and is based on criteria established by product developers. For software products, performance is indicated by the event which combines efficiency in run time and storage space and the achievement of design goals. The efficiency and effectiveness of a software product have long been important considerations in the evaluation of the product's technical worth; and consequently, many rules and procedures for improving them have been suggested, aimed both at the process of managing projects producing software (Brooks, 1975) and at the structure and content of the code (Van Tassel, 1978). These methods are themselves a matter a debate (Spier, 1977), indicating that fixed standards for achieving a high performing software product are not yet generally accepted. Consequently, the judgments of software specialists may vary in the degree to which certain events are seen to be important for software performance.

Generativity

The development of new products is an important concern of software firms. In addition, in order to respond to frequent changes in user needs, a software product must be reworked into a new version of itself. Products that either have valuable parts which contribute to new product development or can be easily modified into new versions of themselves are defined here as generative. Unlike performance, generativity takes place in the long term; but, like performance, generativity is a criterion of success based in the firm.

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[4] Goetz (1978) shows that the income streams from software products are highly unpredictable; long term goals may therefore be seen as qualitatively different from short term product success. (See also Hayes and Abernathy, 1980.)

FIGURE 1

Descriptions of Product Goal Types

A.

Type of Goal	Description
Performance:	The product meets its design goals and runs efficiently in time and space.
Generativity:	The product can be easily made into new versions of itself and contributes to new product development.
Coherence:	The product is accepted, understood and used effectively by users.
Endurance:	The product can meet the new needs of current users and the needs of new users.

B.

Boundary		Term: Short term	Term: Long term
Boundary	Product Development Perspective	Performance	Generativity
	Product User Perspective	Coherence	Endurance

Coherence

A software product is most often used by people outside the organization that developed it. These users are generally unfamiliar with the detailed technical properties of the product but can be expected to understand its purpose and use it effectively. A software firm can work on making its products more understandable and acceptable to users; the verdict, however, is in user perceptions, not those of the developer. The coherence of a product is defined as a type of success involving effective use of the product outside the development rganization and occurs in the short term.

Endurance

Current users of a product will develop new needs which a product must satisfy. Furthermore, new users may have needs for managing information that are different from the needs of old users. The currency of a product refers to its continued viability for old users Like coherence, currency is a function of factors outside the organization. A product's ability to satisfy new requirements, whether or not the product's design has changed, is the key determinant of currency; a product will sometimes do more than it was originally meant to do. Currency, like generativity, implies success in the long term.

In a software products organization,[5] eight nominal groups (Delbeq, Van de Ven and Gustafson, 1975) were run to derive a list of events[6] which were thought by firm members to contribute to software product success in general. The groups produced a list of 352 events which was reduced to 52 through a content analysis. Because these events were elicited by referring to product success in general, some might contribute in the same degree to all four types of product goal and therefore be poor indicators of differences in the ways product goals could be accomplished. To identify these events a pilot test questionnaire was distributed to seven members of the firm, drawn from different functions and hierarchical levels. In the questionnaire

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[5]The company is publicly owned. Current revenues approximate twelve million dollars. The firm has held contracts with most of the large computer hardware manufacturers and continues to benefit from short term contracts with a variety of firms both within and outside the computer business. The firm did not use its own products.

[6]Event is a generic term pertaining to product developer and user behavior, product characteristics, characteristics of the organization, and other factors which firm members see as contributors to product success.

respondents were asked to indicate how strongly (on a five point scale) each of the events led to the accomplishment of each of the four product goals, which were presented according to their descriptions in Figure 1A. Thirty-one events[7] (see Figure 2) were chosen from the results of the pilot test to construct a second questionnaire with the same format. This questionnaire was sent to 150 members of the organization. These members were all those directly involved in either product development, quality assurance or marketing. The participation of these members in the product flow should have provided a basis for answering questions both about the network and how product goals were accomplished. Ninety-three responses were usable, a rate of 62%. No systematic bias across offices or functions was apparent in the responses.

Matrix centered by subject, responses were input to CANDECOMP (Carroll and Chang, 1970) an n-mode, n-way individual differences scaling program (see Carroll and Arabie, 1980). The results of the CANDECOMP procedure showed how the goals, events and individuals were related to the same set of dimensions. These dimensions were expected to be interpreted as <u>term</u> and <u>boundary</u>; the respondent weights on the dimensions, therefore, would indicate the strength with which the <u>term</u> and <u>boundary</u> components of product goals were perceived. Appendix A contains technical details of this procedure.

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[7]A two factor analysis of variance (respondent by type of goal) of the pilot test responses showed that twenty-eight events discrimi nated well among the four types of goal, using the coefficient of generalizability developed by Cronbarch, Gleser, Nanda, and Rajaratham (1982, p.). These events had coefficients ranging from .51 to .91. However, they discriminated less strongly between endurance and the other three product goals than among these three. To increase the potential distinctiveness of endurance, three events were chosen whose mean values on the four types of goal, while not as different as those for the tweny-eight events, showed a pattern of reasonably good discrimination with respect to endurance. These three events also had strong face validity as determinants of product success. In Figure 2 they are nos. 5, 26 and 28.

Figure 2

Events Selected as Contributors to Types of Product Success

1. There is close contact with the end user during development.
2. The developer has a precise picture of who will be using the product.
3. The product is portable across machines.
4. Product structure is modularized.
5. The development team has intrinsic ability.
6. An effective user system can be demonstrated.
7. The price of the product.
8. The vendor is committed to the product.
9. The product has good documentation.
10. The developer knows trends that affect the life of the product.
11. The development company has a good reputation.
12. The product developer supports the user.
13. In a phased approach to product development, each phase is completed by knowledgeable individuals.
14. What base software and hardware the product runs on.
15. Product has unique aspects from the users point of view.
16. Product delivery is on schedule.
17. Product solves a timely problem.
18. The development organization supports the product all the way through.
19. The product is easy to use.
20. The product is easy to install.
21. The terms and conditions associated with licensing and purchasing the product.
22. The product is pilot tested.
23. The level of experience required of the user.
24. The users of the product are trained.
25. The product is highly advanced technologically.
26. The product interfaces easily with existing product of the vendor.
27. Using the product is efficient in terms of human resources.
28. The number of bugs encountered when the product is installed.
29. The product is accurately represented by marketing.
30. The product approaches a problem in a way that seems natural to the user.
31. The user has a specific requirement.

The Network

Task oriented relations in the firm were measured using questions in which respondents made choices from the list of 150 members.[8] For problem referral, feedback on performance, information dependence and resource dependence relationships, a respondent were asked to indicate those to whom s/he "sent" a tie (e.g., referred problem) and those from whom s/he "received" a tie (e.g., received problems referrals). The frequency of problem referral and feedback on performance relations were measured using five point Likert-type scales. Information dependence was assessed for three types of information --technical, marketing and administrative-- and an additional category - more than one type of information; respondents were asked to indicate which other firm members they had depended on or who had depended on them for each of these information types in the period of the previous six months. Finally, four types of discretionary resource transactions -money, time, equipment, and people- and a fifth category -more than one type of resource- were measured. Again, a respondent indicated others on the list of 150 members who had been sources or recipients of resources in transactions involving each of the five resource categories. Ninety-three respondents produced usable questionnaires.

The method used to analyse the raw network data is called blockmodelling (Arabie, Boorman and Levitt, 1979; White, Breiger and Boorman, 1976; Boorman and White, 1976) and involves the use of two algorithms in the present case - CONCOR (Breiger, Boorman and Arabie, 1975) and CALCOPT (Boorman, 1981). CONCOR is a clustering algorithm that splits the membership of the organization into two subgroups or blocks and hierarchically and successively into further blocks until 1) a desired number of subgroups is obtained, or 2)

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[8]Holland and Leinhardt (1973) recommend the listing of all network members as the technique with least inherent measurement error.

the subgroups have roughly a certain number of members. Relationships between blocks, furthermore, may be more or less strong, strength being defined by the relative density of ties between the subgroups' members. The pattern of relationships among blocks is called a blockmodel.

The fit to the data of a blockmodel produced by a clustering algorithm like CONCOR can be evaluated through measures which indicate the dispersion of densities in the density matrix from which the blockmodel is derived (Carrington, Heil and Berkowitz, 1979). In the CALCOPT algorithm used in the present study the index proposed by Boorman and Levitt (1983) was used as a basis for improving the CONCOR partition. That is, the subgroup memberships produced from applying CONCOR to the raw network data were input to CALCOPT as a rational starting configuration; CALCOPT then reallocated members among the subgroups if the index of blockmodel fit was improved.[9]

The number of blocks in the final CALCOPT partition of the network is partially an artifact of the initial configuration provided by CONCOR. To test whether a solution with fewer subgroups might be more strongly related to cognition, the following procedure was used. First, by combining pairs of blocks in the final CALCOPT partition all possible network partitions one block smaller than the CALCOPT solution were constructed. The degree of blockmodel fit using Boorman and Levitt's index was then assessed for each of

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[9]CALCOPT makes a reallocation decision for each member of the network sequentially, taking as given the order of members input (compare the program used in Boorman and Levitt, 1983). The algorithm passes through the population of members iteratively until the reallocation of no member increases the value of the fit index. The program CALCOPT used in the present research was written by the author in APL by modifying an original version programmed by Scott Boorman. The modified version is more efficient and has the capability of deleting a subgroup once its last member has been reallocated.

these partitions, and that partition which had the highest degree of blockmodel fit was selected as the best solution for the coarser level of aggregation. The procedure was repeated on this solution and on subsequent solutions until a partition with only two blocks was established. Thus, network members were aggregated in a set of embedded partitions, each chosen for its fit to the data.[10]

Other Sources of Cognitive Bias

The measurement of individual functional activity and type of product worked on reflects the assumption that the intensity of experience with different functions or product types determines how strongly perceptions of accomplishing product goals will be biased. Intensity here is measured through the frequency, longevity and scope of the activity.

First, the type of product worked on was scaled by longevity and frequency of involvement with the product. A firm member's score for a particular product was computed by multiplying the length of time and the frequency of work on the product. The scores for products of the same type were added to formulate the respondent's score for that type. Similarly, for each of the two roles with product, subject scores were calculated by multiplying the length of time spent working on product times the frequency of time spent on the product and then summing over all products with which the respondent had a particular role. Finally, subject scores for the roles with users were computed by adding the frequency of communications in three modes --face-to-face, telephone and written-- with users for whom the function was

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[10]The procedure used here is similar to that used by Carrington and Heil (1981) in their COBLOC algorithm. The preent approach differs in the target function used and in its inability to pass back through the agglomerative tree to seek a path with a higher ultimate degree of fit than the path chosen sequentially by the degree of fit at each step.

exercised. Tenure in the industry, firm, and job were measured by single questions.

Hypothesis Testing

Although the measurement of both cognition and network position were performed on samples of roughly 62%, measurement of the other predictors of cognition (role, type of product, tenure) reduced the number of usable cases from 93 to 55, resulting in an effective response rate of 37 percent. The pattern of missing data had no systematic relationship with either the results of the scaling solution or the work group structure of the firm (see Kim and Curry, 1977). The 55 cases were therefore accepted as representative of the population.

The hypotheses were tested using analysis of covariance. The effect of network position on cognition and the influence of the other independent variables (role, experience with product, industry, firm and job) were first assessed separately then in conjunction. In this way the degree of interference between the network effect and that of the combined other variables could be evaluated.

RESULTS

The results of the individual differences scaling of judgments by firm members about product goal achievement, shown in Appendix A, indicate that the two theoretical dimensions, term and boundary, could be reliably operationalized. Results of operationalizing the network relations and the analysis of the network are reported in Appendix B. The CALCOPT results are reported here and interpreted in terms of the geographical office structure and reporting structure of the firm.

CALCOPT produced a partition with fourteen blocks which have strong face validity when matched to the geographical office structure of the firm. The fit between geography and group membership is quite strong (see Table 1). The members of groups I to III belong only to the Canadian office. Group IV contains mostly Canadian members. Group V is a large group composed predominantly of the members of the Washington and Far West offices; most of the members of a small separate office in New York are also in this group. Group VI is a small cluster located in Washington, and the remaining groups are located, almost exclusively, in New York. In general, the blockmodel images[11] show substantial overlap, both within and between groups, among the geographically diversified offices.

A graph of the reporting structure is shown in Table 2. Five groups stand out as highly placed in the reporting hierarchy of the firm as a whole: I, in which the head of the Canadian office is located, VXII, X, XII, and XIV. All other groups report directly to at least one of these. Positions X and XIV consist of a single member, and group XII has two members. The identity of these members is important for understanding the reporting structure. The sole member of group X is the firm's technical vice president;

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[11]These data are available from the author upon request.

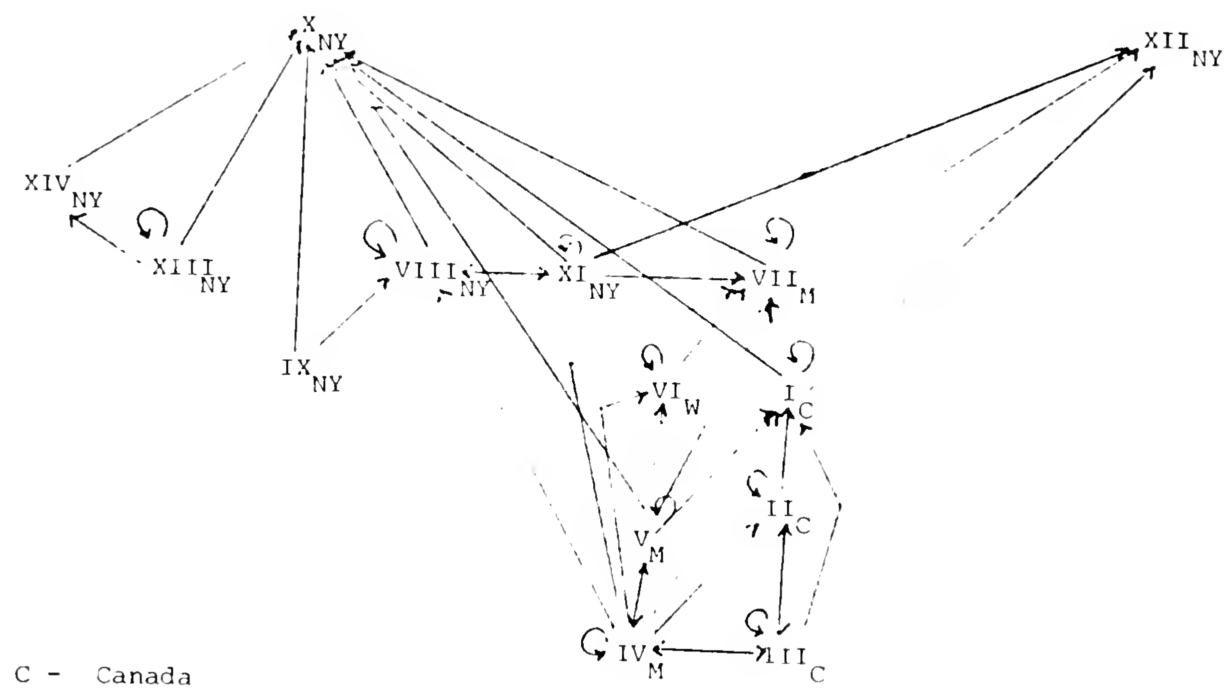
Table 1

CROSS CLASSIFICATION OF CALCOPT PARTITION AND REGIONAL OFFICE MEMBERSHIP

CALCOPT Group	Office				
	Canada	Washington	Far West	NY I	NY II
I	5	0	0	0	0
II	14	0	0	0	0
III	4	0	0	0	0
IV	5	0	1	2	1
V	1	8	8	4	3
VI	0	3	0	0	0
VII	0	1	0	7	0
VIII	0	0	0	5	0
IX	0	0	0	9	0
X	0	0	0	1	0
XI	0	0	0	4	0
XII	0	0	0	2	0
XIII	0	0	0	5	0
XIV	0	0	0	1	0

Table 2

Directed Graph of Interposition Reporting



C - Canada

NY - New York

W - Washington

M - Mixture of geographical offices

one member of group XII is the firm's marketing vice president; and the single member of group XIV is a project team leader whose team is located in group XIII.

The Canadian office (groups I through IV) follows virtually the classic hierarchical reporting pattern (virtually, because of reporting symmetry between groups II, III, and IV). The New York office, however, is fragmented into three hierarchies. Because of the idiosyncratic network positions of the single member groups, X and XIV, and that of the double member group, XII, two of these hierarchies overlap. The first hierarchy in New York is composed of groups XIII, XIV and X; group X is the apex of this order. No other groups report to XIII or XIV nor do groups XIII or XIV report to other groups outside the hierarchy. The second hierarchy consists of groups VII, VIII, IX, X, and XI. The apex of this herarchy again is group X. Groups VIII and XI exchange reporting ties, the only case of symmetric reporting between groups outside Canada. The third hierarchy is groups VII, VIII, IX, XI and XII. The apex is group XII. Thus hierarchies two and three contain the same groups except for their apexes (see Friedell, 1967, for a discussion of such a structure as a semi-lattice).

The overlapping hierarchies in the New York office, therefore, are split between the technical and marketing vice presidents to both of whom group I also reports. The structure of reporting relationships thus provides information on cross-office and intra-office reporting patterns in the firm, and indicates as well potential conflict between the technical and marketing sides of the organization.

The means, standard deviations and ranges of the other independent variables are presented in Table 3. It seemed likely that these variables were strongly associated with network position. To investigate this supposition, a multivariate analysis of variance was conducted between network position and the other predictors (role, experience with product, industry,

Table 3

Descriptive Statistics for Dependent and Independent Variable

	Mean	Std. Dev.	Range
A. Dependent Variables			
Boundary Dimension	6.85	3.74	15.1
Term Dimension	6.94	2.71	14.81
B. Independent Variables			
Nominal Role			
Technical With Product	47.65	76.73	362
Management With Product	25.74	76.96	458
Technical With Users	7.93	12.61	53
Management With Users	1.07	3.87	19
Marketing With Users	1.82	6.4	45
Type of Product Worked On			
Systems Software	91.79	148.5	684
Telecommunications Software	10.42	42.89	240
Applications Software	58.04	116.08	720
Tenure In			
Software Industry	81.96	64.51	237
Software Firm	38.96	42.14	202
Current Job	17.17	19.81	143

firm and job). Using the maximum root test (Anderson, 1958), network position was found to be significantly ($p < .01$) related to the other predictors of both the term and boundary dimensions.[12]

The results for predicting the boundary dimension are shown in Table 4. The null hypothesis that no variables have an effect on perception is rejected ($p < .1$). When the effect of the network is controlled for, two roles, technical with product and management with users, have significant coefficients. The direction of these effects are as predicted: greater time spent in a technical role tends to decrease the salience of the boundary dimension, whereas more frequent communication with users in a management role increases the salience. Network position also significantly influences perception.

The effects of the role variables change when the network is not controlled for. Neither the technical approach to product nor user management remain significant predictors and are replaced by technical role with users, which reduces the salience of the boundary dimension, as hypothesized.

Thus, the role variables, due to their association with network position, are unstable in their effects on perception. The network effect, however, is stable. Moreover, adjusted for degrees of freedom the variance explained by network position (R^2 (adjusted) = .1) is roughly three times that explained by all the role variables combined (R^2 (adjusted) = .03).

Table 5 presents the findings for the effects of tenure, type of product and network position on perceptions of the term dimension. The hypothesis that no coefficients are different from zero is rejected ($p < .05$). When

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[12]The multicollinearity within each set of predictors was found to be insubstantial, using Bartlett's (1950) test for the orthogonality of the determinant of a sample zero-order correlation matrix (see Farrar and Glauber, 1967).

Table 4

Results of Predicting Perceptions of the Boundary Dimension

Equation	Technical Role With Product	Technical Role With Users	Management Role With Product	Mangement Role With Users	Marketing Role With Users	Network Position	R^2	Adjusted R^2
I	-.005	-.092*	.000	.188	-.043		.13	.03
II						.58*	.27	.1
III	-.012**	-.077	-.012	.361*	-.035	.52*	.41	.16

Coefficients are unstandardized estimates

* $p < .1$

** $p < .05$

Table 5

Results of Predicting Perceptions of the Term Dimension

Equation	Systems Software	Applications Software	Tele-communications Software	Industry Tenure	Firm Tenure	Job Tenure	Network Position	R^2	Adjusted $\hat{R}^2$
I	-.002	-.004	.000	.02**	-.023**	.012		.27	.17
II							.07**	.37	.22
III	-.002	-.006**	.001	.015**	-.234**	.023*	.61**	.63	.47

Coefficients are unstandardized estimates

* $p < .01$

** $p < .05$

the effect of the network is not controlled for, firm members with long industry and job tenure perceive the term dimension strongly, as predicted. Contrary to prediction, however, the longer the tenure in the firm, the less salient are differences between short and long term success. In addition, systems and telecommunications products are unrelated to perception of the term dimension; but firm members who are more extensively involved with applications products perceive weaker distinctions between the short and long term success, an effect opposite to that hypothesized. Finally, network position is strongly related to perception of the term dimension, when the covariates are not controlled for.

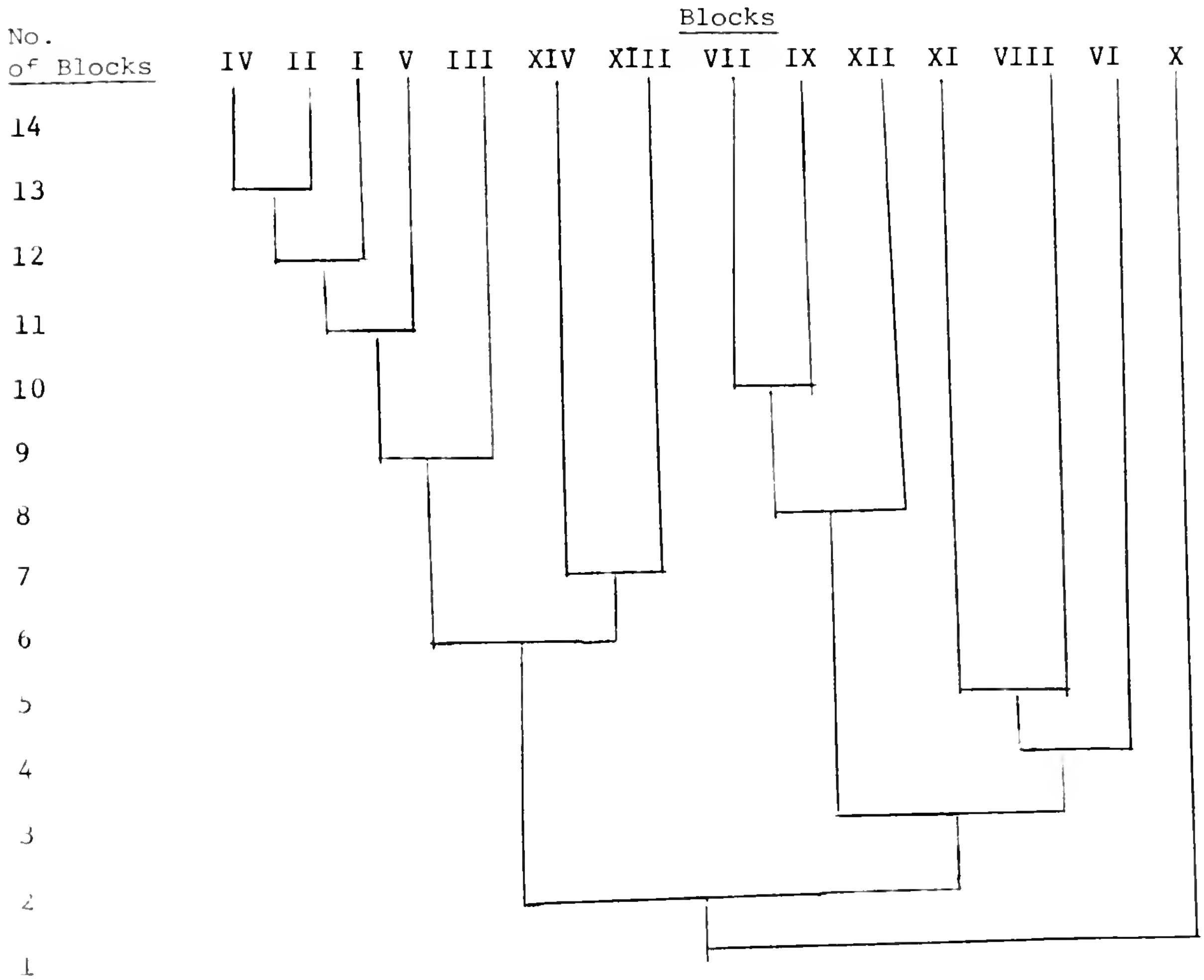
Note that the results for both work on applications products and job tenure are sensitive to the inclusion of network position since, without controlling for the network, neither of these variables determines perception significantly. The influence of network position is significant, however, whether the other independent variables are controlled for. The variance accounted for by network position (R^2 (adjusted) = .22) is, again, larger than that of the other predictors combined (R^2 (adjusted) = .17).

Thus, network position significantly influences individual differences in the perception of the term and boundary dimensions independent of the effects of the other predictors. However, the effects of the other predictors, except for industry and firm tenure, are sensitive to the association with the network.

The results of aggregating network positions on the basis of the minimal reduction in blockmodel fit are found in Table 6. The pattern of aggregation closely fellows the geographical office structure of the firm. In steps one through three the four Canadian blocks are combined, and in step four two blocks located in New York are joined. At the fifth step, subgroup composed of firm members from all office locations is combined with the Canadian

Table 6

Results of Aggregating CALCOPT Partition



blocks. At the sixth step the marketing vice president's block is added to the two New York blocks joined in step four. The project team leader and her team, blocks XIII and XIV, are combined in step seven and, interestingly, added to the Canadian office group at the eighth step. The remaining steps aggregate the New York and Washington blocks, leaving the technical vice president last in a unique singleton block. The pattern of his relationships with the other blocks is thus highly distinctive.

The analysis of covariance findings for the aggregated blocks are presented in Table 7. These results show that the effect of the network on differences in perception of the boundary dimension remains strong and increases in significance as blocks are combined. The same holds true for the network effect on the term dimension until block VI is combined with blocks VIII and XI at the 4-block level of aggregation. In general, the aggregation procedure combines network positions which have similar cognitive orientations towards accomplishing product goals.[13]

To illustrate the cognitive orientations of the subgroups, the plots of individual difference scores for the network members in each block are shown in Table 8. An examination of these plots shows that the (non-singleton) block with the strongest perception of both the term and boundary dimensions is group VI which is composed of experienced middle level managers in New York and the head of the Washington office. Note also that among the Canadian's

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[13]In general, when there are fewer network blocks, the role variables affect perceptions of the boundary dimension in the same pattern as for the fourteen block partition. Technical role with product and management role with users have significant effects when the network is entered into the equation but not in its absence; technical role with users influences the salience of the boundary dimension when the network is not controlled for but not in its presence. The results for the term dimension also folllow the same pattern as the 14-block analysis.

Table 7

Results of Analyses of Covariance at Different Levels of Network Aggregation

A. Prediction of Boundary Dimension

No. of Blocks	R^2 for All Variables	R^2 for Network	Adjusted R^2 for Network
13	.406	.27	.14
12	.406	.24	.12
11	.38	.23	.13
10	.38	.22	.14
9	.37	.21	.14
8	.37	.21	.14
7	.37	.21	.14
6	.37	.20	.15
5	.34	.17	.14
4	.29	.16	.14
3	.26	.13	.13
2	.26	.13	.13

B. Prediction of Term Dimension

No. of Blocks	R^2 for All Variables	R^2 for Network	Adjusted R^2 for Network
13	.57	.36	.25
12	.53	.32	.22
11	.53	.27	.16
10	.48	.24	.10
9	.48	.24	.16
8	.48	.24	.18
7	.48	.24	.18
6	.48	.24	.20
5	.30	.14	.11
4	.28	.07	.05
3	.28	.05	.05
2	.28	.05	.05

Table 8A

Plot of Respondent Scores on Boundary Dimension

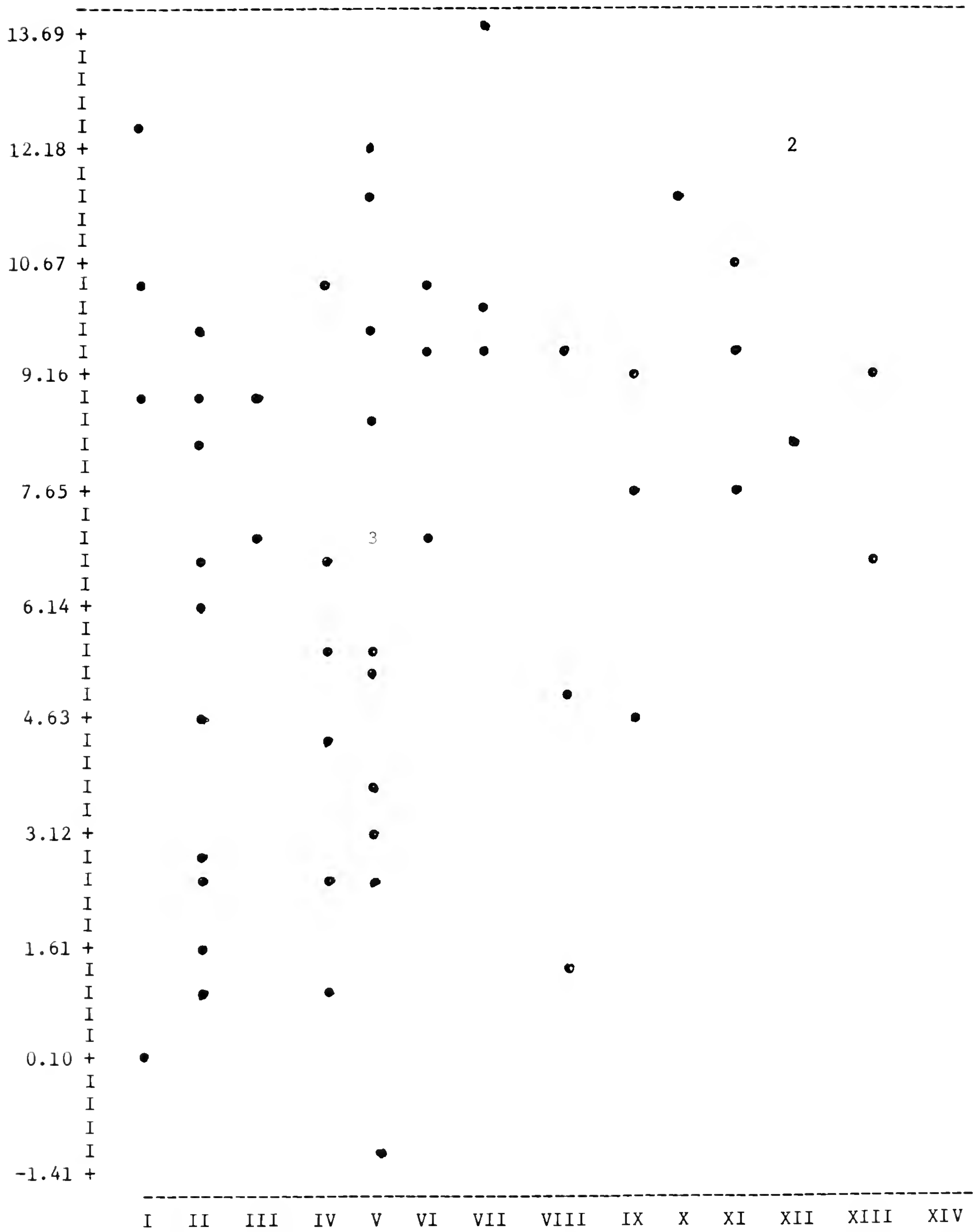
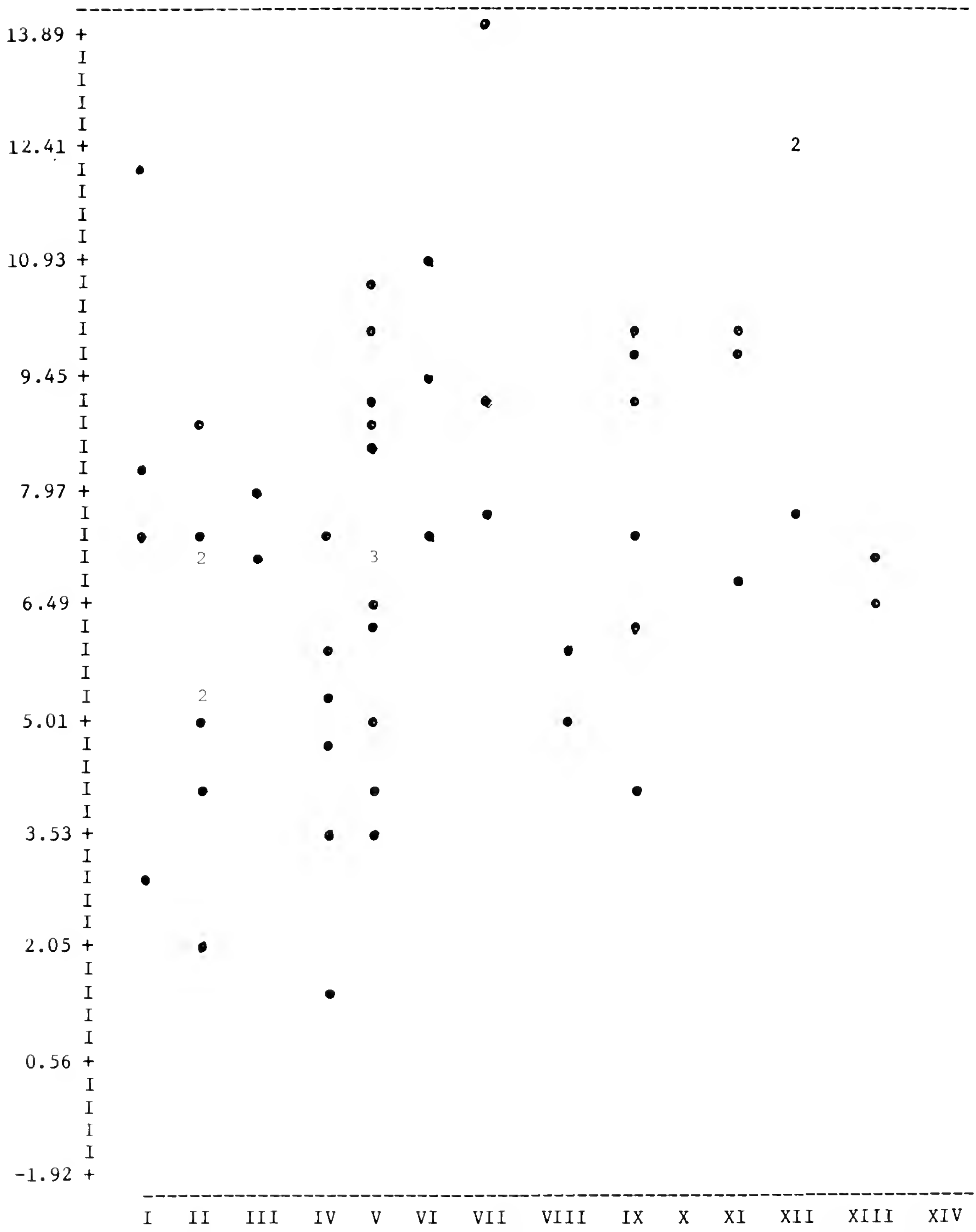


Table 8B

Plot of Respondent Scores on Term Dimension



subgroups block I, which contains the head of the office, has the highest values on both cognitive dimensions.

Discussion

The results show that with the exception of industry and firm tenure, the predictor variables have unstable effects, due to intercorrelation with position in the network. Network position itself has a strong independent influence on cognition. However, pairs of subgroups at the 14-block level are not clearly differentiated in their cognitive orientations towards product success. Thus, although the network supercedes the influence of other factors, such as nominal role and experience with product, the effect of the network is due primarily to the relatively distinct cognitive profiles of a small number of groups.

Contrast this result with strong pairwise differentation of work groups on task uncertainty dimensions found by Van de Ven, Koenig and Delbecq (1976). In fact, the firm studied in the present research represents the organizational version of what Van de Ven, Koenig and Delbecq call a systems development group, which faces high task variability and uncertainty and is characterized by a dense task network. In a sense, then, the present study has focused on one type of task situation, characterized by high uncertainty, and examined individual differences in the perception of task outcomes specific to that setting. Organizational members were assumed to use the same dimensions in their perceptions of task outcomes because of the high density of interaction in the firm; differences in the salience of those dimensions, however, were predicted by the distribution of task goals and information as represented by the structure of the network. Consequently, the lack of strong pairwise inter-block differentation in the present study may represent the relatively high but homogenous level of task uncertainty faced by organizational members. However, had the organization faced more than one

level of uncertainty, neither the assumption of common cognitive dimensions across members nor the prediction of the network's influence on cognition could have been made.[14]

Furthermore, in addition to the high level of technological and product/market uncertainty, the labor intensity and relatively small size of the firm increased the likelihood that the network would have substantial density. High density of interaction improved the chances that members used similar dimensions to categorize events and that the organization-wide network, viewed from a structural equivalence point of view, influenced

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[14] It would not be correct to interpret the cognitive orientations of the blocks in terms of the reporting relationships shown in Table 2 since all five types of task relation were used to determine the blocks. The relative contribution of each type to perceptions of how product goals are accomplished remains a task for future research. Furthermore, perceptual differences among the blocks do not perfectly reflect the reporting structure as the reporting relationship and cognitive profile of blocks IX and VIII demonstrate.

Nor would it be correct to interpret the results as an artifact of the geographical office structure for a number of reasons. First, although there is a tendency for subgroups in the same geographical office to be combined in the aggregation procedure, the effect of the network on perceptions of the <u>term</u> and <u>boundary</u> dimensions remains strong after the geographical office boundaries have been blurred in coarser network partitions (see especially the merger of the Canadian offices and blocks XIII and XIV at step 6). Also, had geography been focused on alone neither the mixed blocks, IV, V and VII nor the extensive cross-office links would have been identified. mixed blocks indicate cross-office similarity of task relationships within the organization as a whole; and of these subgroups, VI shows most clearly how commonality of cognitive perspective among managers cuts across function, product and geographical boundaries. Finally it should be noted that when the population of network members is defined as the organization rather than the geographical office, office members are placed in the same blocks because of the similarity of their task relationships with the rest of the firm; when the network is defined as the office, however, the block memberships may change because an actor's relationships outside the office are not being analysed. Analyses performed individually of the large office networks, Canada and New York, might be related to their internal cognitive differentiation in the same way that cognition is related to the network of the whole organization as shown in Tables 2 and 3. Thus arguments for the cognitive homogeneity of the various offices and for inter-office heterogeneity should take into account the level of analysis, organization or office, at which the network positions are derived. (Note, in this regard, that the range of cognitive scores for both Canada and New York are approximately equal.)

cognitive content. Consequently, the generalizability of the effect of the network on cognition may be limited by characteristics of the organization studied.

The characteristics of the firm may also limit the type of cognition studied. The intensive technology of the firm made it more likely that members in a variety of nominal roles had some interaction with the firm's customers, thus increasing the likelihood that the boundary dimension was a relevant parameter of product success. Also, technological change, the market growth rate, and rate of new entry into the industry indicate a high level of product market uncertainty so that product-related problems could be typed as ill-structured and the term dimension could be specified as a practical parameter of product goals.

The influence of firm and industry tenure on the salience of the term dimension point to the need for relatively high executive turnover in fast growth industries experiencing technological change. Once within a firm, veterans lose their perspective and fail to distinguish between the different ways of achieving product success in the short and long term. This result could simply reflect a high burn-out rate in the organization. The result may also be due to the degree of structure in the judgment situation studed here. Organizational members may learn solutions to well-structured problems early in their tenure and expand on this knowledge in innovative but incremental ways as the influence of socialization diminishes. On the other hand new firm members may feel forced to structure highly uncertain judgment situations in which older members are willing to see more ambiguity, thus reducing the sharpness with which the term dimension is perceived. The results of the present study regarding socialization in the firm therefore may represent the tendency of older firm members to appreciate the ill-structured nature of the judgment task. However, because the task was not specific to the firm but applied to the software industry in general, experience in the industry

provided information which increased perception of differences between short and long term success. Industry and firm tenure therefore influence judgment for badly structured industry-specific problems in opposite ways.

To the extent that network position determines cognition, it affects the inputs to decision making and therefore to a degree decision outcomes. On the other hand, a member's position in the network itself reflects the global pattern of individual choices about product related issues as represented by the types of task-oriented relations. These choices furthermore are a consequence of previous decisions about the projects the organization would undertake, as organizational members use their contacts to accomplish project aims (Kotter, 1982). The present study shows that this process itself determines individual orientations towards product success and therefore constrains cognitive input to new decision-making situations. Thus the network transforms the implementation of one set of decisions into the premises by which another set is made.

To what degree can this process be managed? This question has provoked a number of qualitative models of organizational (as opposed to individual or small group) decision processes. Among these are Gouldner's (1959) distinction between the rational and natural system perspectives (see also Thompson, 1967), Cohen, March and Olsen's (1972)) garbage can model and Weick's (1976) model of loosely coupled systems. Both Cohen, March and Olsen's and Weick's models approach the problem of management by specifying where control is absent.

Weick points out that interaction among organizational members and therefore the network of interactions may be a tightly coupled aspect of an organization. The association of means and ends may be either tightly or loosely coupled. Since the results of the present research show that the network is related to the way organizational members perceive the uniqueness of means and ends linkages, tightly and loosely coupled systems may be joined

as the content of interpersonal interaction becomes the content of causal inferences. The latter may involve either unique or ambiguous means/ends associations (March, 1978), which in turn should be related to the degree of choice flexibility inherent in the system.

Cohen, March and Olsen's garbage can model specifies four loosely coupled decision situation parameters. These parameters are: choice situations, participants, problems, and solutions. The results of the present study show that the position of participants in an interaction network determines to an extent their orentiation towards problems and solutions proposed in a choice situation. In a sense, the network acts as a selection and retention mechanism in the evolution of decision-making within the firm. (Notice that problems and solutions with ambiguous means and ends may be selected for.)

The network model in the present study also can be seen as a bridge between Gouldner's rational and natural system models of organization. The link to the natural system follows from the discussion above of how the network relates to the garbage can and loosely coupled systems models of organizational decision making. The network is related to the rational system model through the covariance of the various types of task-oriented tie. Task-oriented relationships can be partially manipulated by those with power to prescribe formal ties between individuals. Informal ties should be correlated with formal relationships, and so the structure of the network is to some extent determined by the powerful group. Assessing the covariance among formal and informal types of tie and the relative contribution of each type to individual differences in cognition are important analytical tasks for evaluating how strongly the network has been rationalized.

Furthermore, task-oriented relationships measured in the present study involved both information and direction relevant to the accomplishment of product goals. The transmission of direction indicates an influence process

which some organizational members may manage by maintaining strategically located positions in the network for one or more types of relation (Marsden, 1981). Thus control may be exerted both by specifying formal relationships throughout the firm which affect in various degrees the development of other types of ties and by managing the flow of task-related direction through structurally determined influence. Further research should show whether these aspects of control over organizational decision-making affect inferences about product goals independently.

Finally, the present study has not examined the ways in which affect might constrain or mediate the relationship between organization and cognition. Both affective input to decision-making and the network of interpersonal relationships based on affect may be empirically separable from and perhaps independent of the type and determinants of cognition studied in the present research (see, for example, Zajonc, 1981). Further research might identify how inferences and feelings about events are related to position in a network composed of both instrumental and expressive ties. Heise (1979, p. 32-34) suggests, for example, that an individual develops his or her network of interpersonal relationships by selecting others with or through whom affect can be controlled and that cognition is a function of this process. Boorman and White (1976) found in their study of network structures, however, that members of formal organizations tended to suppress negative sentiment in comparison with actors in informal settings. These results suggest that the demands of task accomplishment in formal organizations constrain network development of the kind proposed by Heise. Task demands may themselves be a function of affect management strategies, as organizational members establish task-oriented relationships with others who share sufficiently their orientations towards accomplishing product goals. An analysis of the relationships among positions in a task-oriented network should show whether

such a correspondence between relational and cognitive continuities exists, and if so, whether the structure of positive affect ties can be matched to it.

CONCLUSIONS

The present study is the first of which the author is aware that examines the network structure of an organization (as opposed to functional or managerial group) and how the position of a firm member in that structure affects his/her perception of how specific outcomes are accomplished. The research is limited, however, because it was performed in a single organization with specific characteristics enabling the measurement of cognition in ill-structured judgment situations and its relationship to the network. Furthermore, only one kind of cognition was studied. Further inquiry into the network's influence on the task perceptions of firm members should focus on broadening its scope across types of cognition and locating the range of its generalizability across different types of organizations.

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Appendix A

Measurement of Causal Models

Table A1 presents the results of the two-dimensional CANDECOMP scaling solution [15]. The locations of the events and the types of success are shown together in the two dimensional space. An interesting characteristic of this scaling solution is the high correlation between the dimensions. CANDECOMP does not necessarily produce orthogonal axes, and a commonly cited advantage of the technique is the rotation invariance of the solution (see Carroll and Arabie, 1980, p. 631). It was not possible, therefore, to rotate the axes to increase their interpretability.

The horizontal axis can be labeled the boundary dimension since along it product development types of success are clearly differentiated from the user types. Likewise, the vertical axis can be labeled the term dimension, since the long term types of success lie above the short term types. Note that the development types of success are much closer together on the boundary dimension than the user types, and the user types of success are closer together on the term dimension than the development types.

Although the term dimension is interpretable, the quadrilateral predicted by the product sucess typology is not perfectly produced: endurance lies between coherence and performance rather than occupying the fourth corner of what should be a rhombus. The location endurance makes the interpretation of the axes more difficult, especially the interpretation of the term dimension.

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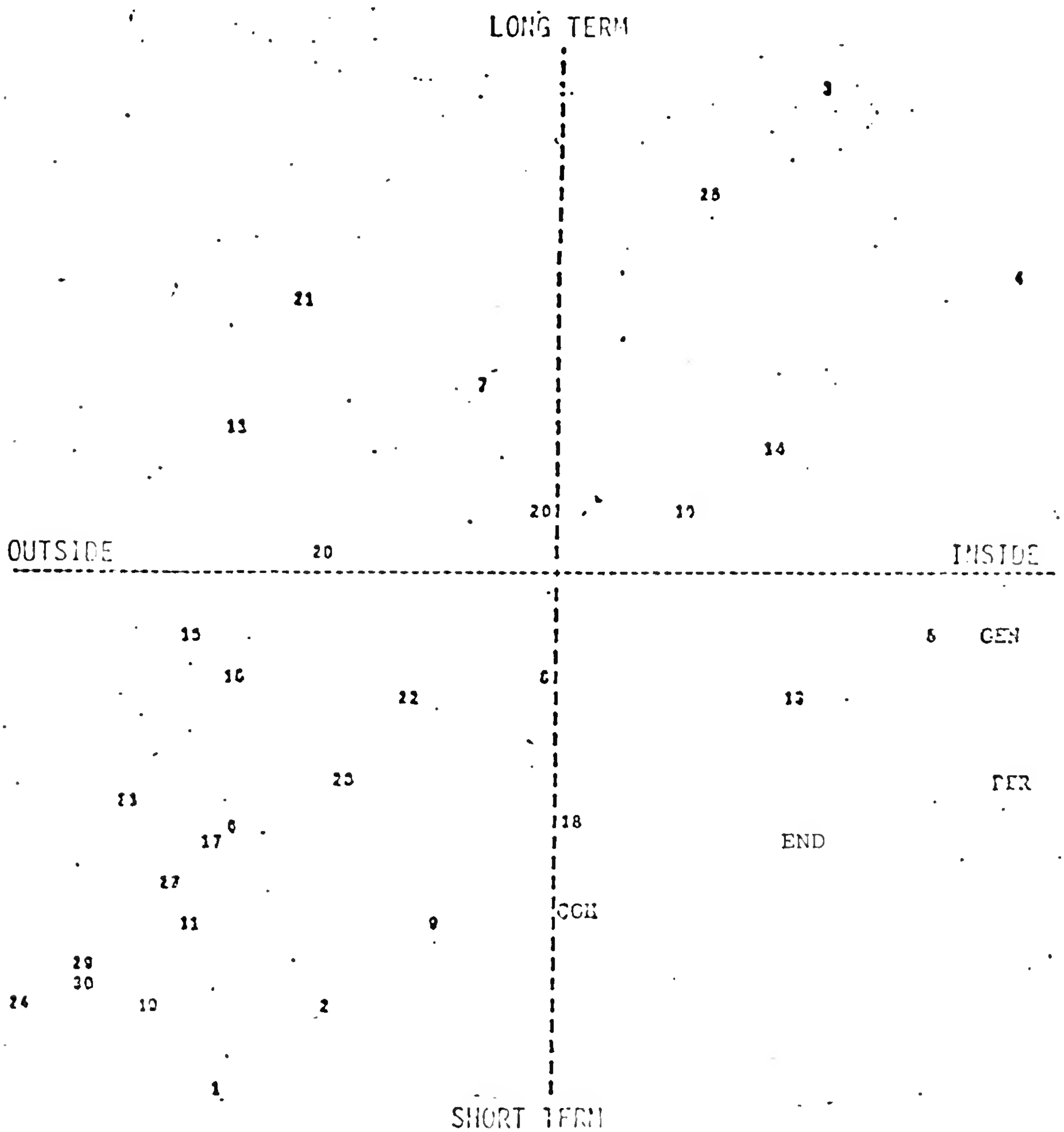
[15] Nine CANDECOMP runs with different randomly chosen initial configruations were made. For all runs, the three dimensional solution explained approximately five percent more of the variance in subject scores than the two dimensional solution. The two dimensional solution was therefore selected for interpretation. The run which offered the best interpretation in terms of the type of success weights was selected to test the hypotheses. The patterns of events and types of success in all solutions were quite similar.

TABLE A1

CANDECOMP Scaling of Thirty-one Events and Four Types of Product

Success - R^2 = .30



Numerals refer to events in Table 1.

The distribution of the events reinforces the interpretation of the dimensions based on the locations of the types of success. Users become more prevalent in events moving from right to left on the horizontal axis, indicating a shift from product success inside to product success outside the organization. Also, at the top of the right side of the space are events which describe characteristics of the product, and at the bottom of the right side are events that describe aspects of the development process, indicating that product characteristics are generally associated with long term success and aspects of development with short term success. However, on the left side of the space, user-product and user-organization relationships are less separable.

The wide vertical spread of events in the right side of the space is consistent with the strong differentation between performance and generativity on the term dimension. The narrow dispersion of the events in the left side reflects the relatively short distance between coherence and currency. This funnelling effect in the distribution of events and types of success is an important result since it demonstrates that subjects have difficulty differentiating between short and long term success when judged by users but no difficulty when success occurs in the eyes of product developers.

To test the stability of this result across time and method four pairs of events were selected from the solution, each pair from a region of the spare that could be associated with a particular type of success. Four months after the first questionnaire was distributed a subset of 65 firm members were asked to compare the eight events, in pairwise fashion, in terms of the similarity of their contribution to product success <u>in general</u> (that is, the types of product success were not mentioned). Responses were input to INDSCAL, a two-mode, three-way individual differences scaling program (Carroll and Chang, 1970; Carroll and Arabie, 1980) with a two dimensional solution

specified. A canonical correlation analysis of the eight event weights on the axes of the CANDECOMP and INDSCAL solutions showed a significant correspondence for both the boundary and term dimensions, $p < .001$ and $p < .1$, respectively.[16]

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[16]The question remained whether the types of success were actually perceived as ends for which the thirty-one events were means. To test this assumption, the eight events taken from the four regions of the CANDECOMP solution were presented with the types of success to the sixty-five firm members in Tversky and Kahnemann's (1980) format designed to identify the existence of causal features. The results showed causality links between the events and all types of success, except currency, which, contrary to expectation, was seen more frequently as causing the events. This outcome helps to explain the distorted position of currency in the scaling results and the funnelling of events on the left side of the CANDECOMP solution.

Appendix B

Measurement of Network Position

In measuring the network, reporting was measured as a binary variable. Responses for feedback and problem referral, which were measured on an ordinal scale, were dichotomized (see Arabie, Boorman and Levitt, 1979, pp. 42-43). The cutoff criterion for each of these relations was median split; that is, relationships which occurred more often than the median frequency were given a value of one and those occuring less frequently were assigned a value of zero. Of the five types of extra resources --time, money, people, equipment and more than one type of resource-- only time and more than one type of resource had a sufficient number of responses to be included in the analysis. Each of the three types of information measured --technical, marketing, and administrative-- had sufficient density to be included in the analysis.[17]

Dependence for information of more than one type was also included. In all, then, seventeen separate relations were used to constitute the network:

1. reporting
2. feedback given
3. feedback received
4. problems given
5. problems received
6. extra time given
7. extra time received
8. more than one kind of resource given
9. more than one kind of resource received
10. technical information given
11. technical information received
12. marketing information given
13. marketing information received
14. administrative information given
15. administrative information received
16. more than one kind of information given
17. more than one kind of information received

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[17] Low density or sparse relations were eliminated for both substantive and technical reasons. Substantively, relations which were underrepresented in the population had insufficient scope to convey product-related goals and information. Technical difficulties also arose in analysing such relations due to the large number of firm members who did not participate in them.

Frequencies for the categories of each relation are presented in Table B1. Because the analysis was performed on the seventeen types of tie together, organizational members who belonged to the same position were structurally equivalent across all the relations simultaneously. Thus, using a large number of functional ties to define the network increased the robustness of the position memberships produced by the blockmodelling techniques. The significance of measurement error in any one relation for the results was thus substantially reduced.[17]

Binary matrices for each of these relations were stacked (see Arabie, Boorman and Levitt, 1978, pp. 36-37) and submitted to CONCOR. After successive splitting, 14 groups were identified.[18] The splitting sequence is shown in Table B2A. The partition produced by CONCOR was used as a rational initial configuration for CALCOPT. The initial value of the CALCOPT target function using the CONCOR partition was 215.94, and the terminal value was 452.45, a substantial increase. The number of members in each group after CALCOPT was applied is shown in Table B2B. The CALCOPT partition, like that of CONCOR, contains 14 groups.[19]

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[18] No hard and fast rule exists for the number of groups to be derived. In the present case, groups were split if their size was twelve members or greater, unless, as in one case, the split resulted in separating only one member from the group. Splitting at twelve resulted in groups whose sizes were generally consistent with project teams in the firm.

[19] To test the stability of the responses for each relation, an identical questionnaire was distributed two months later. The correlations of responses across the two questionnaires for the seventeen relations range from .41 (help with extra time received) to .73 (reporting).

TABLE B1

FREQUENCY OF RESPONSE FOR NETWORK RELATIONS

A. Reporting

1. Average number of reporting ties per respondent: 1.13

Total Number of Response Per Category

B. Feedback

	Less than once a month	Roughly every month	Roughly every two weeks	Roughly every week	Roughly every day
1. Feedback received	90	51	41	61	26
2. Feedback sent	96	48	38	94	28

C. Problem Referral

	Less than once a month	Roughly every month	Roughly every two weeks	Roughly every week	Roughly every day
1. Problems received	95	42	28	41	23
2. Problems sent	129	42	38	43	20

D. Help With Extra Resources

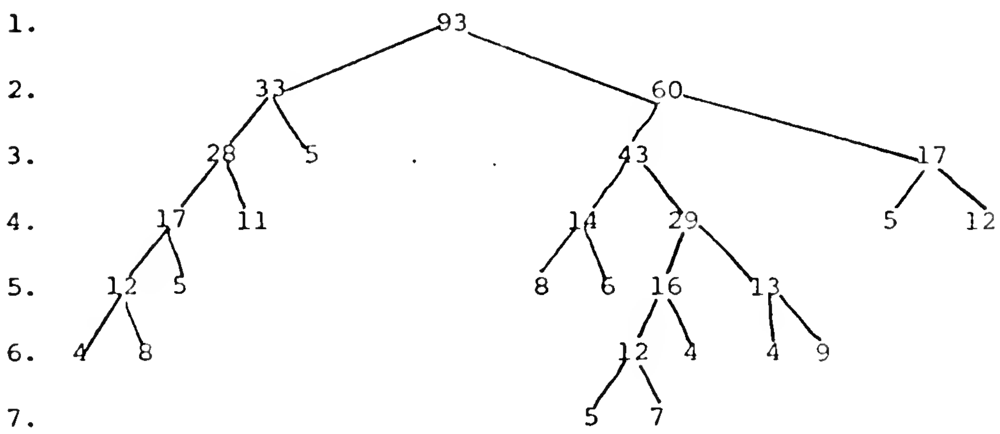
	Time	Money	People	Equipment	More than one kind
1. Help received	26	1	12	5	87
2. Help sent	98	1	8	2	130

E. Dependence for Information

	Technical	Marketing	Administrative	More than one kind
1. Information received	270	73	57	62
2. Information sent	262	79	34	80

TABLE B2
CONCOR SPLITTING SEQUENCE AND CALCOPT PARTITION

A. CONCOR Splitting Sequence



B. CALCOPT Partition Cell Counts

8 9 4 14 23 5 5 4 5 2 9 1 1 3

Target Function Values:

CONCOR Partition: 215.94

Final CALCOPT Partition: 452.54